Science & Global Security, 22:163–165, 2014
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ISSN: 0892-9882 print / 1547-7800 online
DOI: 10.1080/08929882.2014.952130

Editors' Note

As of the end of 2013, Russia had the largest number of highly enriched uranium fueled research reactors of any country, with 59 steady state and pulsed reactors, and critical and sub-critical assemblies. In most cases, the fuel is weapon-grade highly enriched uranium (HEU), enriched to 90 percent uranium-235. Anatoli Diakov's article "Prospects for Conversion of HEU-Fueled Research Reactors in Russia" reviews the prospects for the conversion to non-weapon-usable low-enriched uranium fuel of Russian 17 civilian steady state research reactors fueled by HEU, which together contained over 500 kg of HEU. In December 2010, Russia and the United States agreed to conduct a preliminary study on the possibility of converting six Russian research reactors. The conversion of these six particular reactors will not, however, significantly reduce the annual consumption of HEU in Russia's civilian research reactor fleet. The article suggests that the lack of priority given to reactor conversion is in part a result of the fact that 14 of the 17 HEU-fueled research reactors have been operating for more than 30 years and many are not in use for a large fraction of the available time. Converting some of these reactors is not seen as worth the costs of development, testing and purchase of replacement low-enriched fuel. For some reactors, their high neutron flux density and unique experimental capabilities, e.g., for development of fast reactor fuels, is seen as irreplaceable by low-enriched fuel or computer simulations. Conversion of such reactors is seen as potentially taking a long time and as being costly, thus delaying other programs and being a financial drain on research reactor operators.

To overcome these obstacles to converting Russia's civilian HEU-fueled research reactors, the article recommends an audit of all Russian nuclear research facilities to identify which facilities are no longer necessary, and which new facilities may be required to support Russian nuclear power development efforts while still complying with Russia's nuclear safety and non-proliferation obligations to minimize the use of HEU fuel. To achieve this goal, the article recommends further that Russia find funding for the decommissioning of unnecessary nuclear research installations, the conversion of the research reactors, and the construction of new research facilities.

As with HEU, Russia's policies regarding plutonium, the other commonly used nuclear weapon material, are also of concern to the international community. Russia has the largest stockpile of plutonium of any country: the stockpile is estimated to be about 179 tons, which includes almost 51 tons of separated civilian plutonium as of December 2012, and 34 tons of plutonium that have been declared excess for weapons purposes. In 2000, Russia and the United States concluded a Plutonium Management and Disposition Agreement (PMDA) that committed each to dispose of at least 34 tons of weapon-grade plutonium. This was amended in 2010 to allow plutonium disposal to begin in 2018 with a minimum target rate of disposal of 1.3 tons/year. The 2010 PMDA amendment permits Russia to use its 34 tons of excess weapon-grade plutonium as mixed plutonium-uranium oxide (MOX) fuel in its BN-600 and BN-800 fast breeder reactors. The implications of this plutonium disposal approach are analyzed in "Plutonium Disposition in the BN-800 Fast Reactor: An Assessment of Plutonium Isotopics and Breeding" by Moritz Kütt, Friederike Frieß, and Matthias Englert.

Using the MCMATH code, developed by the IANUS group at Darmstadt University in Germany, Kütt, Frieß, and Englert present neutron transport and depletion calculations of the BN-800 core and its radial and axial blankets to show that less than about 10% of the initial weapon plutonium inventory in the MOX fuel would be consumed. They find that with axial and radial blankets, the BN-800 would not significantly reduce plutonium stockpiles—operating for 420 full power days at 80 percent capacity, the reactor would be refueled with 1.79 tons of the excess plutonium in MOX each year, and the discharged spent fuel would contain 1.64 tons of plutonium. The plutonium in the discharged MOX however would no longer be weapon-grade (taken as 94 percent plutonium-239), since the plutonium-240/plutonium-239 ratio is found to have increased to more than 0.1. The analysis finds that the reactor blankets would produce over 160 kg per year of super-grade weapon plutonium (with over 97 percent plutonium-239). The article recommends that at a minimum Russia should consider operating the BN-800 reactor without axial and radial blankets so that it serves as a plutonium disposal program, rather than as a plutonium recycle program, and that alternative disposal options should be developed.

The third article in the issue seeks to improve the capabilities of the Comprehensive Nuclear-Test-Ban Treaty Organization's International Monitoring System (IMS) to detect nuclear explosions. In their article "Determination of the Global Coverage of the IMS Xenon-133 Component for the Detection of Nuclear Explosions," Michael Schoeppner and Wolfango Plastino use atmospheric transport modelling of radioxenon isotopes from nuclear explosions to determine the limits of the IMS global network of 39 operating noble gas monitoring stations (out of a planned set of 40 stations worldwide), which aims to provide a 90 percent probability of detection of a nuclear explosion within 10 days. The analysis includes the effects of the varying radioxenon background from medical isotope production facilities and nuclear power plants around the world, which leads each noble gas monitoring station to have a different and time-dependent xenon-133 background signal.

The article tests the coverage of the 39 IMS radioxenon detector stations by considering equally spaced surface and sub-surface nuclear explosions. It finds that "blind spots" exist in the IMS noble gas component where the detection probability of nuclear explosions is lower in some locations and during some times of year. It finds that radioxenon emitting facilities have a negative regional impact on the detection coverage. One issue is that the IMS monitoring stations have been located more or less uniformly over the globe and this distribution does not include the effects of meteorological patterns and background emissions. The article recommends adding additional IMS radioxenon stations in equatorial regions and in regions with marked radioxenon background, as well as agreeing limits on maximum radioxenon emissions especially from medical isotope production facilities.